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IRON ORES - DETERMINATION OF MANGANESE CONTENT BY FLAME ATOMIC ABSORPTION SPECTROMETRY
STATISTICAL EVALUATION OF INTERNATIONAL TEST DATA - 1984

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(For submission to ISO/TC 102/SC 2/WG 26A and to the Secretariat of ISO/TC 102/SC 2)

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Project MRP-3.8.01.11
Analytical Methodology

MINERALS RESEARCH PROGRAM
MINERAL SCIENCES LABORATORIES
DIVISION REPORT MRP/MSL 85-41 (IR)

MICROMEDIA

IRON ORES - DETERMINATION OF MANGANESE CONTENT BY FLAME ATOMIC ABSORPTION SPECTROMETRY
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by

R. Sutarno* and W.S. Bowman**

SUMMARY

The analytical data resulting from the international test conducted by ISO/TC 102/SC 2/WG 26A on the determination of Mn in iron ores by Flame Atomic Absorption Spectrometric method during the period of 1982/84 have been statistically evaluated. Based on these analytical results, the preliminary estimate of the precision can be expressed in terms of the Mn concentration by the following equations:

$$r = 0.0174\ X + 0.0045$$
$$P = 0.0475\ X + 0.0026$$
$$\sigma_r = 0.0062\ X + 0.0016$$
$$\sigma_L = 0.0162\ X + 0.0005$$

where X is the Mn concentration in the sample, r is the repeatability, P is the permissible tolerance, σ_r is the within-laboratory standard deviation and σ_L is the between-laboratories standard deviation, all in mass %. Four samples containing Mn ranging from 0.01 to 2.5% were used in this test. Comparison was made with the precision obtained by standard methods ISO 3088 and JIS M 8215.

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MINERAIS DE FER - DÉTERMINATION DE LA TENEUR EN MANGANÈSE AU MOYEN DE LA SPECTROMÉTRIE D'ABSORPTION ATOMIQUE À FLAMME ÉVALUATION STATISTIQUE DES DONNÉES D'UN ESSAI INTERNATIONAL - 1984

par

R. Sutarno* et W.S. Bowman**

RÉSUMÉ

Les données analytiques qui ont résulté de l'essai international effectué de 1982 à 1984, par le Groupe de travail 26A du Sous-comité 2 du Comité technique 102 de l'Organisation internationale de normalisation (ISO) en vue de déterminer la teneur en Mn de minerais de fer par la méthode de la spectrométrie d'absorption atomique à flamme, ont fait l'objet d'une évaluation statistique. Selon ces résultats analytiques, l'estimation préliminaire de la précision peut être exprimée en terme de concentration de Mn à l'aide de la formule suivant:

$$r = 0.0174\ X + 0.0045$$
$$P = 0.0475\ X + 0.0026$$
$$\sigma_r = 0.0062\ X + 0.0016$$
$$\sigma_L = 0.0162\ X + 0.0005$$

où X représente la concentration en Mn de l'échantillon; r, la répétibilité; P la tolérence; σ_r, l'écart-type de chaque laboratoire, et σ_L, l'écart-type de l'ensemble des laboratoires, le tout exprimé en pourcentage (%) de la masse. Quatre échantillons ayant une teneur en Mn de 0,01 % à 2,5% ont été utilisés aux fins de l'essai. La comparaison a été effectuée avec la précision que permettent les méthodes normalisées ISO 3088 et JIS 8215.

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INTRODUCTION

At the eleventh meeting of ISO/TC 102/SC 2 - International Organization for Standardization, Technical Committee 102 - Iron Ores, Subcommittee 2 - Chemical Analysis, the delegates agreed to establish a new working group (WG 26A) to develop a standard method for the determination of manganese by flame atomic absorption spectrometry for the concentration range of 0.01 - 2.5% Mn. (Resolution 32). The convenership of this working group was entrusted to E.S. Pilkington of Australia, and six countries (Australia, Brazil, France, Italy, Japan and Sweden) agreed to participate.

The working group conducted an international test involving 4 test samples with manganese contents ranging from 0.01 to 2.5%. The purpose of this international test was to give the opportunity to the members of the working group to assess the analytical method as well as to obtain a preliminary estimate of its precision. The analytical method is described in detail in document ISO/TC 102/SC 2 N 761 E (1). It was still in the first draft stage at the time of this test. Eighteen laboratories representing seven countries participated. The analytical results were collected, statistically evaluated and reported to the convener in time for the twelfth meeting of the sub-committee.

This report describes the full account of the statistical evaluation of the data obtained.

PRINCIPLE OF ANALYTICAL METHOD[1]

Decomposition of the test portion by treatment with hydrochloric acid with the addition of a small amount of nitric acid.

Evaporation to dehydrate silica, addition of hydrochloric acid, dilution and filtration. Ignition of the residue and removal of silica by evaporation with hydrofluoric and sulphuric acids. Fusion with sodium carbonate and sodium tetraborate and dissolution of the cooled melt in hydrochloric acid.

Aspiration of the combined solutions into the flame of an atomic absorption spectrometer using a dinitrogen oxide-acetylene flame. Comparison of the absorbance values obtained with those obtained from calibration solutions.

STATISTICAL EVALUATION

The analytical data were statistically evaluated using the procedure described in document ISO/TC 102/SC 2 N 739E[2]. This procedure is schematically illustrated in Figure 1. The raw data are also plotted in Figure 2. The boxed points in these figures signify that these data are suspected outliers and were not used to estimate the grand means and precision. The estimated precisions are plotted against their corresponding means in Figure 3. Linear regression equations of these lines were also computed and presented in Table 1. Table 2 lists suspected outliers. These estimated precisions are compared with those of a spectrophotometric method (document 2 N 226E[3]) and an atomic absorption spectrometric method (JIS M 8215), presented in Tables 3 and 4 respectively.

OBSERVATION

Precisions listed in Table 1 seem to be reasonable; they are comparable with both the spectrophotometric method (document 2 N 226E[3]) which was the basis for ISO 3088 (Table 3) and those obtained by the Japanese standard method JIS M 8215 (Table 4)[4]. The σ_L/σ_r ratios with the exception of sample 83-8 (2.5% Mn) are less than 2, the unofficial bench mark of SC. There are other encouraging signs: (1) that there is only one outlying laboratory (Table 2) and (2) that the within-laboratory variances are homogeneous (Appendix A). Combined with reasonable σ_L/σ_r ratios, it can be interpreted that the method is relatively well standardized; i.e. no participating laboratory had any difficulty applying the method.

Indeed, having received the convener's report, the subcommittee has decided to conduct the precision experiment for this method.

REFERENCES

1. "Iron ores - Determination of manganese content - Flame atomic absorption spectrometric method", ISO/TC 102/SC 2 (WG 26A - 1) N 761E, September 1983.

2. "Procedure for statistical evaluation of analytical data resulting from international tests", ISO/TC 102/SC 2 N 739E, April 1981.

3. "Results of international analytical trials on manganese by photometric method", ISO/TC 102/Sc 2 (Secretariat - 65) 226E, June 1971.

4. "Japanese member body of ISO/TC 102/SC 2" - Private communication.

Table 1.

ISO/TC 102/SC 2/WG 26A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY

SUMMARY OF PRECISIONS FOR ALL SAMPLES

ELEMENT	SAMPLE	KO	K	NO	N	MEAN(X)	REPEATABILITY	PERMISSIBLE TOLERANCE	SIGMA-R	SIGMA-L	SIGMA-L/SIGMA-R
MANGANESE	76-16	18	17	53	51	.0114	.0018	.0036	.00062	.00119	1.91
MANGANESE	83-7	18	18	53	53	.0870	.0051	.0102	.00178	.00336	1.88
MANGANESE	76-12	18	18	53	53	.7739	.0236	.0338	.00833	.01038	1.25
MANGANESE	83-8	18	18	53	53	2.5295	.0469	.1243	.01659	.04231	2.55

THE REGRESSION EQUATIONS ARE:

					CORR. COEFF.
R	=	.0174 X	+	.0045	.9830
P	=	.0475 X	+	.0026	.9976
SIGMA-R	=	.0062 X	+	.0016	.9830
SIGMA-L	=	.0162 X	+	.0005	.9954

Table 2.

ISO/TC 102/SC 2/WG 26A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY

LIST OF OUTLIERS

ELEMENT	SAMPLE	COCHRAN (PRECISION)	DIXON (ACCURACY)	LAB HAS ONLY ONE RESULT	INDIVIDUAL OUTLYING RESULT (DIXON)
MANGANESE	76-16	-	AU 3	-	-
MANGANESE	83-7	-	-	-	-
MANGANESE	76-12	-	-	-	-
MANGANESE	83-8	-	-	-	-

Table 3.

ISO/TC 102/SC 2 - MANGANESE IN IRON ORES DOC. 226E (JUNE,1971)

SUMMARY OF PRECISIONS FOR ALL SAMPLES

SAMPLE	MEAN(X)	REPEATABILITY	PERMISSIBLE TOLERANCE	SIGMA-R	SIGMA-L
1	6.4185	.1230	.3401	.04347	.11619
2	2.6441	.0336	.1419	.01186	.04945
3	.6170	.0157	.0270	.00554	.00871
4	.2014	.0103	.0166	.00365	.00526
5	.0177	.0019	.0102	.00067	.00356

THE REGRESSION EQUATIONS ARE:					CORR. COEFF.
	=	.0140 X	+	.0037	.9958
	=	.0397 X	+	.0127	.9952
SIGMA-R	=	.0049 X	+	.0013	.9958
SIGMA-L	=	.0136 X	+	.0043	.9940

Table 4.

MANGANESE BY AAS JIS MS215 - 1983

SAMPLE	MEAN(X)	REPEATABILITY	PERMISSIBLE TOLERANCE	SIGMA-R	SIGMA-L
1	.0248	.0026	.0083	.0010	.0029
2	.2129	.0073	.0140	.0026	.0046
3	.4918	.0084	.0196	.0033	.0065
4	.7330	.0193	.0573	.0068	.0197

THE REGRESSION EQUATIONS ARE:

					CORR. COEFF.
R	=	.0214 X	+	.0019	.9546
P	=	.0639 X	+	.0014	.8975
SIGMA-R	=	.0076 X	+	.0007	.9541
SIGMA-L	=	.0219 X	+	.0004	.8919

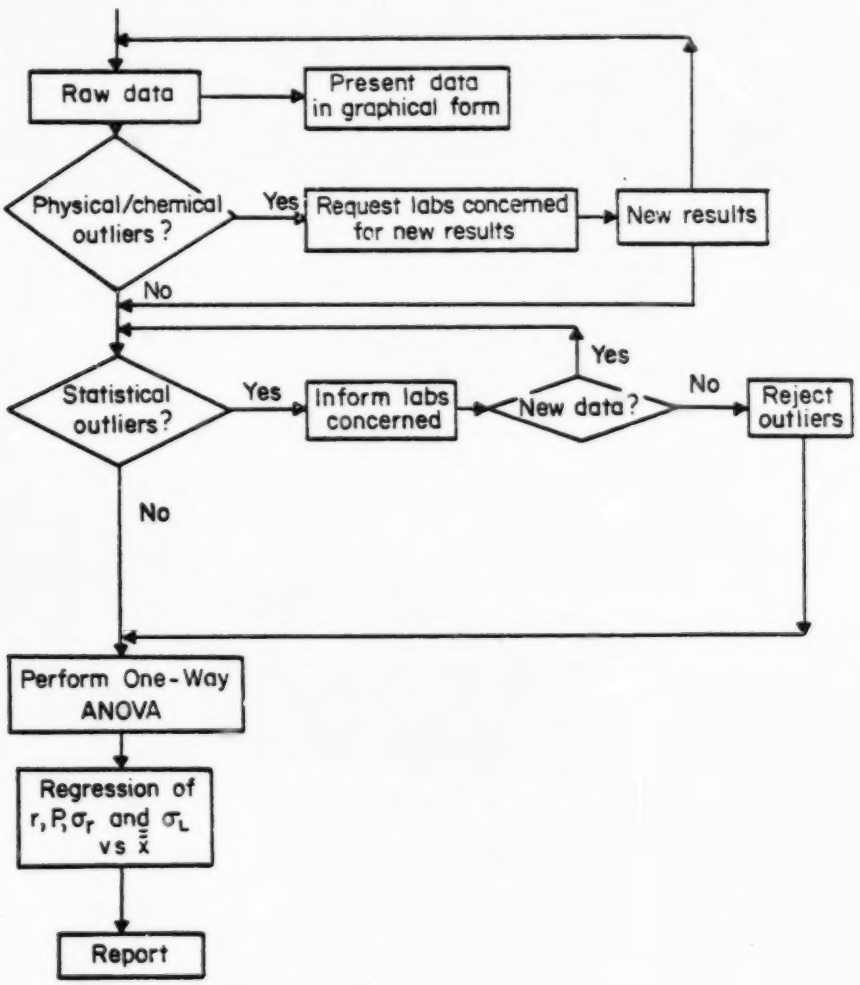

Figure 1. Flow Chart of the Procedure for Statistical Evaluation of Analytical Data Resulting from International Tests

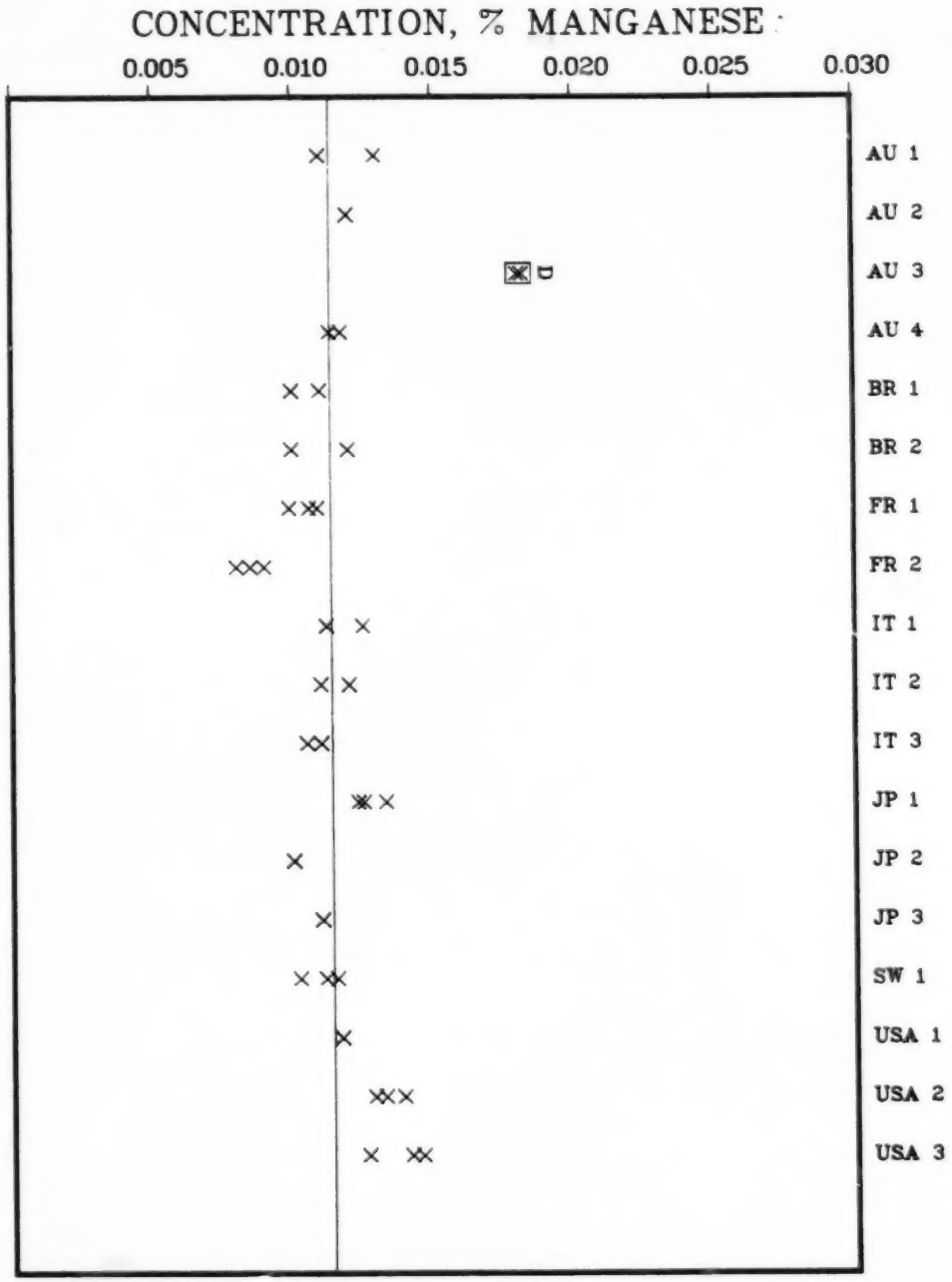

Figure 2.1

ISO/TC 102/SC 2/WG 26A – MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY

SAMPLE: 76-16 SISHEN-SARM-11 MANGANESE WT %

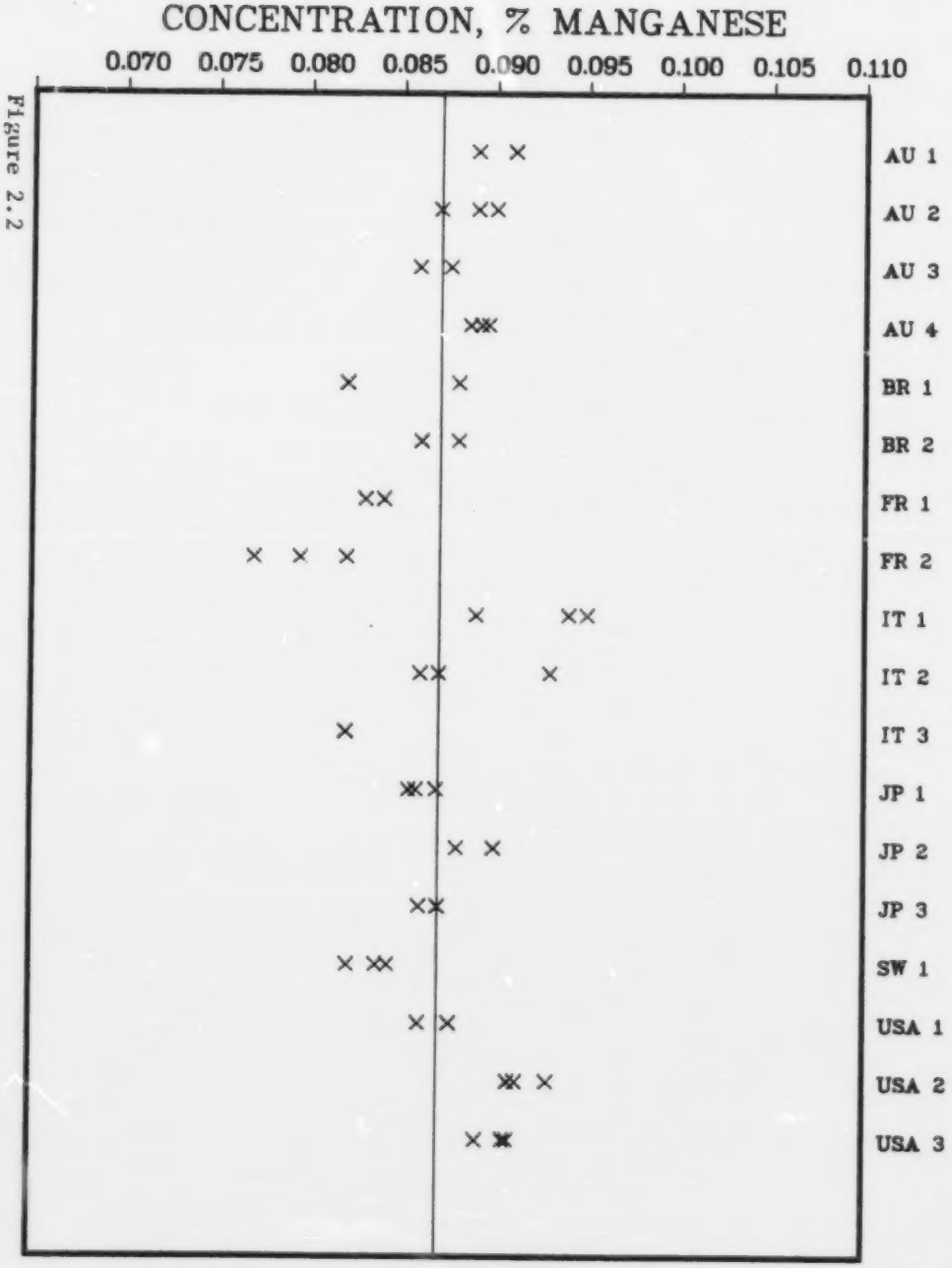

Figure 2.2

ISO/TC 102/SC 2/WG 26A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY

SAMPLE 83-7 HAMERSLEY MANGANESE WT %

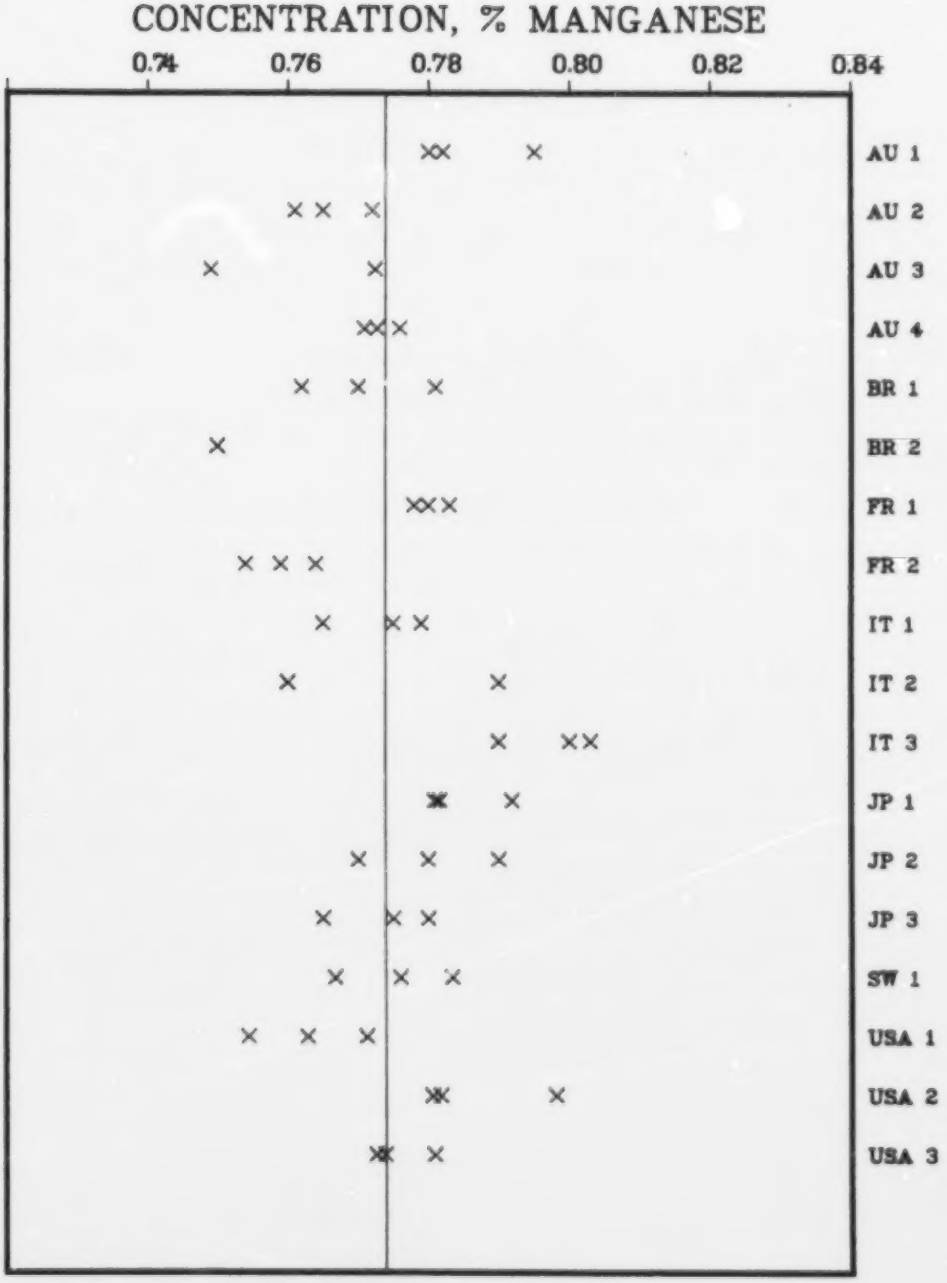

Figure 2.3

ISO/TC 102/SC 2/WG 28A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY

SAMPLE 76-12 CANADA SCH-1 MANGANESE WT %

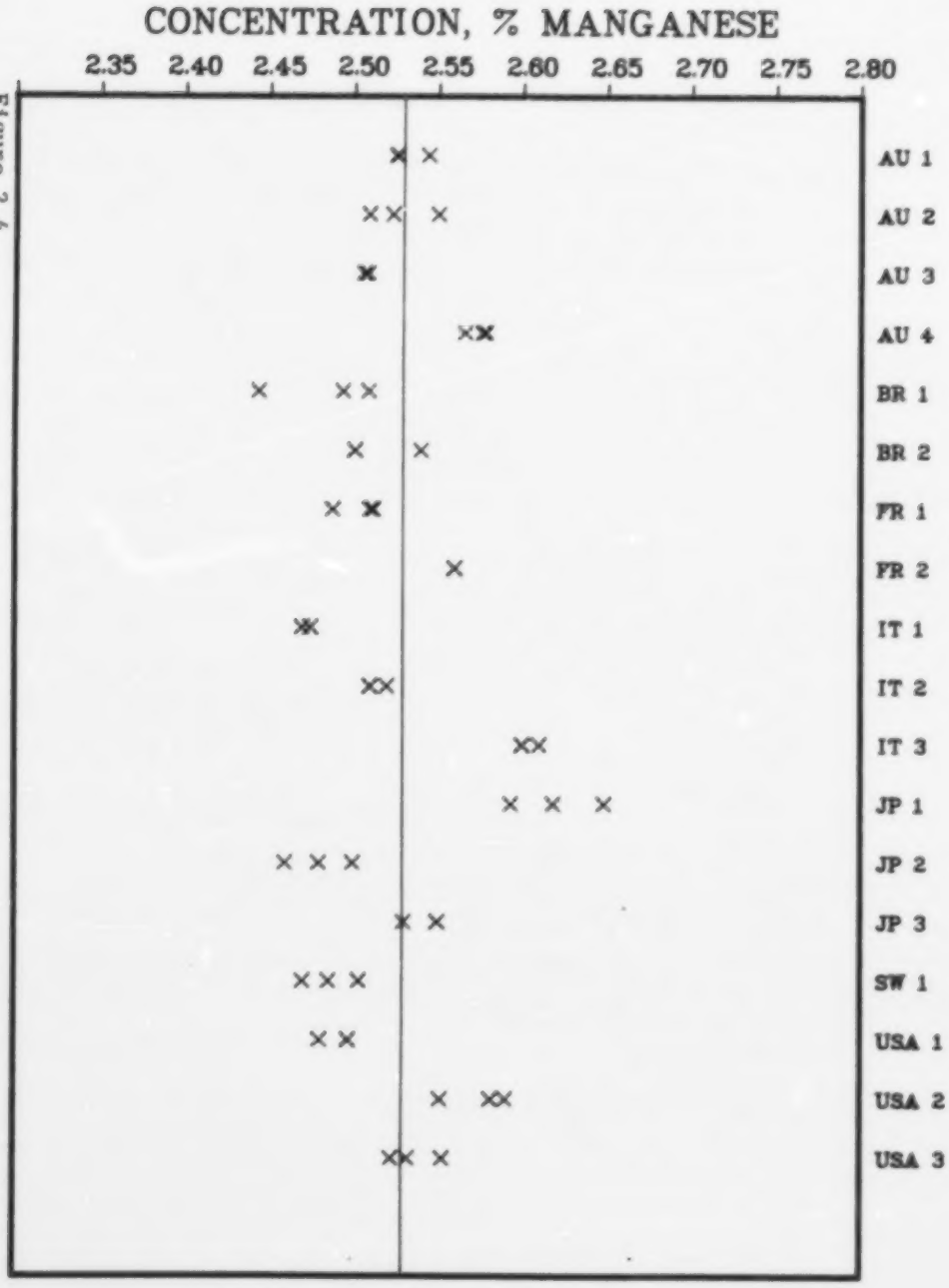

Figure 2.4

ISO/TC 102/SC 2/WG 28A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY

SAMPLE 83-8 CANADA WABUSH MANGANESE WT %

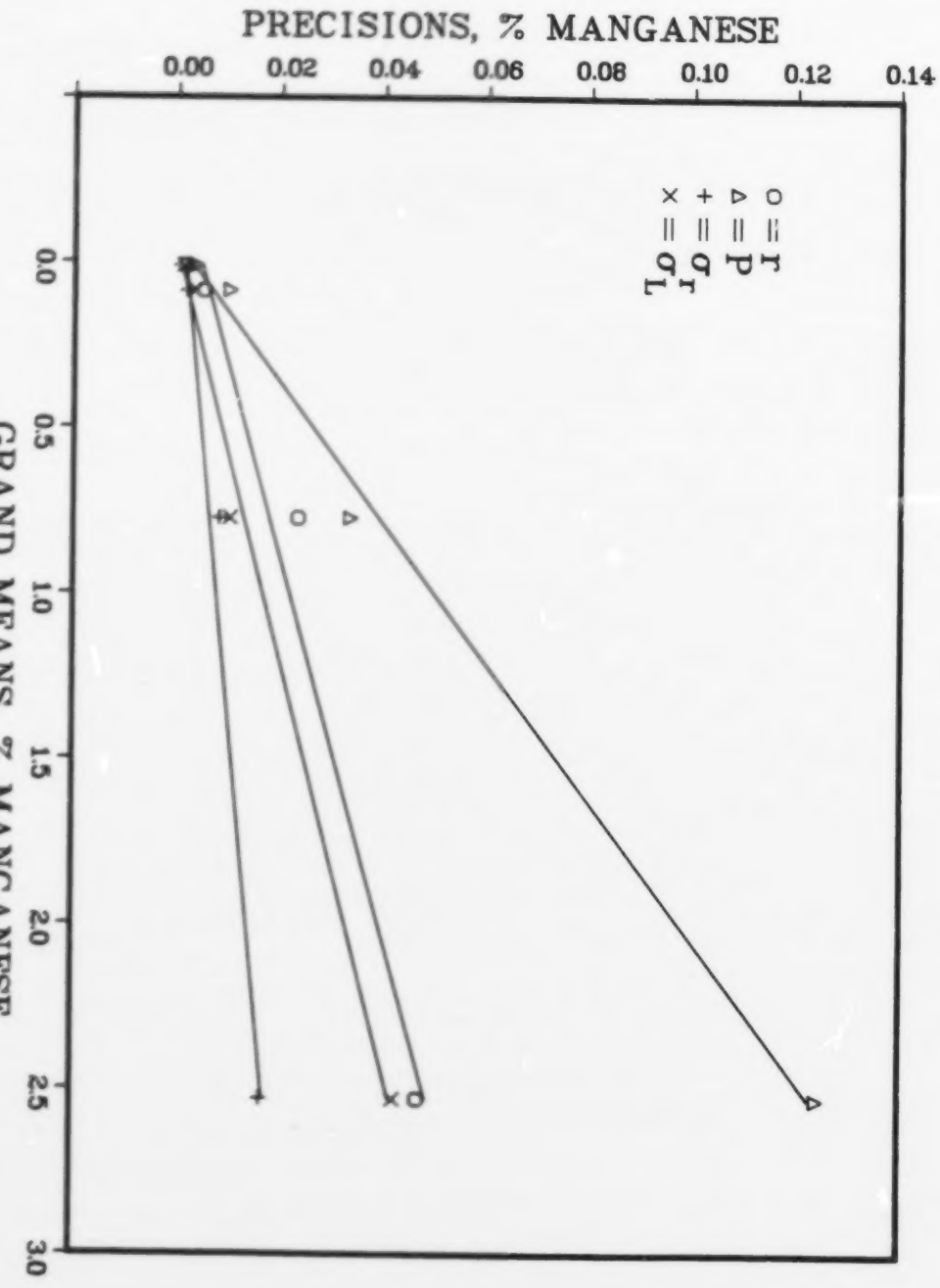

Figure 3.

ISO/TC 102/SC 2/WG 26A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY

ISO/TC 102/SC 2/WG 26A

APPENDIX A

Detailed Computation of the Analytical Data

ISO/TC 102/SC 2/WG 26A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY
SAMPLE: 76-16

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS			LAB MEAN	LAB VARIANCE
1	AU 1	1	.0110	.0130	.0110	.01167	.1333E-05
2	AU 2	1	.0120	.0120	.0120	.01200	0.
3	AU 3	1	.0182	.0181		.01814	.1280E-07
4	AU 4	1	.0118	.0114	.0118	.01163	.5333E-07
5	BR 1	1	.0110	.0100	.0100	.01033	.3333E-06
6	BR 2	1	.0120	.0120	.0100	.01133	.1333E-05
7	FR 1	1	.0099	.0109	.0106	.01047	.2633E-06
8	FR 2	1	.0080	.0090	.0085	.00850	.2500E-06
9	IT 1	1	.0112	.0112	.0125	.01163	.5633E-06
10	IT 2	1	.0120	.0120	.0110	.01167	.3333E-06
11	IT 3	1	.0110	.0105	.0110	.01083	.8333E-07
12	JP 1	1	.0133	.0123	.0125	.01270	.2800E-06
13	JP 2	1	.0100	.0100	.0100	.01000	0.
14	JP 3	1	.0110	.0110	.0110	.01100	0.
15	SW 1	1	.0102	.0111	.0115	.01095	.4581E-06
16	USA 1	1	.0117	.0117	.0117	.01167	0.
17	USA 2	1	.0132	.0128	.0139	.01331	.2817E-06
18	USA 3	1	.0145	.0126	.0141	.01375	.1038E-05

ISO/TC 102/SC 2/WG 26A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY
SAMPLE: 75-16

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	10.334
CHI-SQUARE(.95,13)	22.367

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DIXON'S TEST FOR LABORATORY MEANS

LAB- 3 R = .619 D-CRIT(18) = .515

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

LAB- 3 DIXON'S TEST FOR LABORATORY MEANS

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 26A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY
SAMPLE: 76-16

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	16	.74001416E-04	.46250885E-05
WITHIN LABS	34	.13208267E-04	.38847843E-06
TOTAL	50	.87209682E-04	

REPEATABILITY VARIANCE	.38847843E-06
REPEATABILITY STD. DEV.	.00062328
BETWEEN-LABORATORIES VARIANCE	.14122033E-05
BETWEEN-LABORATORIES STD. DEV.	.00118836
REPEATABILITY	.00176388
PERMISSIBLE TOLERANCE BETWEEN LABS	.00359690
GRAND MEAN	.01137941
VARIANCE OF THE GRAND MEAN	.90688009E-07

ISO/TC 102/SC 2/WG 26A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY
SAMPLE: 83-7

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS			LAB MEAN	LAB VARIANCE
1	AU 1	1	.0910	.0890	.0910	.09033	.1333E-05
2	AU 2	1	.0870	.0900	.0890	.08867	.2333E-05
3	AU 3	1	.0859	.0876		.08672	.1394E-05
4	AU 4	1	.0896	.0892	.0886	.08913	.2487E-06
5	BR 1	1	.0880	.0820	.0920	.08400	.1200E-04
6	BR 2	1	.0880	.0860	.0860	.08667	.1333E-05
7	FR 1	1	.0830	.0840	.0840	.08367	.3333E-06
8	FR 2	1	.0770	.0820	.0795	.07950	.6250E-05
9	IT 1	1	.0890	.0940	.0950	.09267	.1033E-04
10	IT 2	1	.0860	.0870	.0930	.08867	.1433E-04
11	IT 3	1	.0820	.0820	.0820	.08200	0.
12	JP 1	1	.0869	.0858	.0854	.08603	.6033E-06
13	JP 2	1	.0880	.0900	.0900	.08933	.1333E-05
14	JP 3	1	.0870	.0870	.0860	.08667	.3333E-06
15	SW 1	1	.0837	.0821	.0843	.08338	.1256E-05
16	USA 1	1	.0877	.0860	.0877	.08712	.9075E-06
17	USA 2	1	.0913	.0930	.0908	.09168	.1260E-05
18	USA 3	1	.0906	.0891	.0908	.09019	.8465E-06

ISO/TC 102/SC 2/WG 26A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY
SAMPLE: 83-7

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	21.555
CHI-SQUARE(.95,16)	26.301

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DIXON'S TEST FOR LABORATORY MEANS

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 26A, - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY
SAMPLE: 83-7

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	17	.61951115E-03	.36441832E-04
WITHIN LABS	35	.11147138E-03	.31848967E-05
TOTAL	52	.73098253E-03	

REPEATABILITY VARIANCE	.31848967E-05
REPEATABILITY STD. DEV.	.00178463
BETWEEN-LABORATORIES VARIANCE	.11298831E-04
BETWEEN-LABORATORIES STD. DEV.	.00336137
REPEATABILITY	.00505050
PERMISSIBLE TOLERANCE BETWEEN LABS	.01016095
GRAND MEAN	.08702887
VARIANCE OF THE GRAND MEAN	.69160411E-06

ISO/TC 102/SC 2/WG 26A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY
SAMPLE: 75-12

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS			LAB MEAN	LAB VARIANCE
1	AU 1	1	.7800	.7950	.7820	.78567	.6633E-04
2	AU 2	1	.7650	.7720	.7610	.76600	.3100E-04
3	AU 3	1	.7490	.7724		.76070	.2738E-03
4	AU 4	1	.7727	.7759	.7709	.77317	.6413E-05
5	BR 1	1	.7620	.7810	.7700	.77100	.9100E-04
6	BR 2	1	.7500	.7500	.7500	.75000	0.
7	FR 1	1	.7780	.7830	.7800	.78033	.6333E-05
8	FR 2	1	.7540	.7640	.7590	.75900	.2500E-04
9	IT 1	1	.7790	.7750	.7650	.77300	.5200E-04
10	IT 2	1	.7600	.7500	.7900	.77000	.3000E-03
11	IT 3	1	.7900	.8000	.8030	.79767	.4633E-04
12	JP 1	1	.7919	.7809	.7816	.78480	.3793E-04
13	JP 2	1	.7700	.7900	.7800	.78000	.1000E-03
14	JP 3	1	.7650	.7750	.7800	.77333	.5833E-04
15	SW 1	1	.7760	.7667	.7834	.77537	.7002E-04
16	USA 1	1	.7628	.7712	.7544	.76280	.7056E-04
17	USA 2	1	.7805	.7981	.7817	.78677	.9669E-04
18	USA 3	1	.7738	.7725	.7808	.77570	.1993E-04

ISO/TC 102/SC 2/WG 26A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY
SAMPLE: 76-12

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	12.128
CHI-SQUARE(.95,16)	26.301

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DIXON'S TEST FOR LABORATORY MEANS

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 26A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY
SAMPLE: 76-12

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	17	.65758009E-02	.38681182E-03
WITHIN LABS	35	.24295467E-02	.69415619E-04
TOTAL	52	.90053475E-02	

REPEATABILITY VARIANCE	.69415619E-04
REPEATABILITY STD. DEV.	.00833160
BETWEEN-LABORATORIES VARIANCE	.10783332E-03
BETWEEN-LABORATORIES STD. DEV.	.01038428
REPEATABILITY	.02357844
PERMISSIBLE TOLERANCE BETWEEN LABS	.03378754
GRAND MEAN	.77387170
VARIANCE OF THE GRAND MEAN	.73367247E-05

ISO/TC 102/SC 2/WG 26A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY
SAMPLE: 83-8

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS			LAB MEAN	LAB VARIANCE
1	AU 1	1	2.5260	2.5250	2.5440	2.53167	.1143E-03
2	AU 2	1	2.5090	2.5230	2.5500	2.52733	.4343E-03
3	AU 3	1	2.5084	2.5062		2.50730	.2420E-05
4	AU 4	1	2.5783	2.5765	2.5659	2.57357	.4489E-04
5	BR 1	1	2.4940	2.4440	2.5090	2.48233	.1158E-02
6	BR 2	1	2.5400	2.5010	2.5010	2.51400	.5070E-03
7	FR 1	1	2.5120	2.5100	2.4880	2.50333	.1773E-03
8	FR 2	1	2.5600	2.5600	2.5600	2.56000	0.
9	IT 1	1	2.4750	2.4750	2.4700	2.47333	.8333E-05
10	IT 2	1	2.5100	2.5100	2.5200	2.51333	.3333E-04
11	IT 3	1	2.6000	2.6000	2.6100	2.60333	.3333E-04
12	JP 1	1	2.6484	2.5934	2.6184	2.62007	.7583E-03
13	JP 2	1	2.5000	2.4600	2.4800	2.48000	.4000E-03
14	JP 3	1	2.5500	2.5300	2.5500	2.54333	.1333E-03
15	SW 1	1	2.4859	2.5036	2.4706	2.48670	.2727E-03
16	USA 1	1	2.4974	2.4974	2.4807	2.49183	.9296E-04
17	USA 2	1	2.5905	2.5521	2.5817	2.57477	.4047E-03
18	USA 3	1	2.5329	2.5335	2.5232	2.53653	.2394E-03

ISO/TC 102/SC 2/WG 26A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY
SAMPLE: B3-6

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	19.987
CHI-SQUARE(.95,16)	26.301

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DIXON'S TEST FOR LABORATORY MEANS

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 102/SC 2/WG 26A - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY
SAMPLE: 83-8

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	17	.94260525E-01	.55447368E-02
WITHIN LABS	35	.96278267E-02	.27508076E-03
TOTAL	52	.10388835E+00	

REPEATABILITY VARIANCE	.27508076E-03
REPEATABILITY STD. DEV.	.01658556
BETWEEN-LABORATORIES VARIANCE	.17903319E-02
BETWEEN-LABORATORIES STD. DEV.	.04231231
REPEATABILITY	.04693713
PERMISSIBLE TOLERANCE BETWEEN LABS	.12425834
GRAND MEAN	2.52945283
VARIANCE OF THE GRAND MEAN	.10525503E-03

ISO/TC 102/SC 2/WG 2&3 - MANGANESE BY ATOMIC ABSORPTION SPECTROMETRY

SUMMARY OF PRECISIONS FOR ALL SAMPLES

SAMPLE	MEAN(X)	REPEATABILITY	PERMISSIBLE TOLERANCE	SIGMA-R	SIGMA-L
1	.0114	.0019	.0036	.00062	.00119
2	.0370	.0051	.0102	.00178	.00336
3	.7733	.0236	.0339	.00833	.01038

THE REGRESSION EQUATIONS ARE:				CORR. COEFF.
R	=	.0290 X	+ .0020	.9987
P	=	.0375 X	+ .0049	.9930
SIGMA-R	=	.0096 X	+ .0007	.9988
SIGMA-L	=	.0113 X	+ .0017	.9905

APPENDIX C

Abbreviations Used in this Report

σ_r = SIGMA-R - within laboratory standard deviation

σ_L = SIGMA-L - between laboratories standard deviation

r* = R - repeatability

= $2.83 * \sigma_r$

p** = permissible tolerance between laboratories

= $2.83 \sqrt{\sigma_L^2 + \sigma_r^2/2}$

* Repeatability, r, is the value below which the absolute difference between two independent single test (analysis) results produced by a laboratory on identical material using the same equipment within a short interval of time, using the standardized test method, may be expected to be with a 95% probability.

** Permissible tolerance between laboratories, P, is the value below which the absolute difference between two means of duplicate test results on identical material obtained by operators of different laboratories using the standardized test method, may be expected to lie with a 95% probability.

COUNTRY ABBREVIATIONS

Au = Australia

FR = France

IT = Italy

JP = Japan

SW = Sweden